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BOTTLENOSE DOLPHIN STOCK STRUCTURE RESEARCH PLAN FOR THE CENTRAL NORTHERN GULF OF MEXICO

BY

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I. INTRODUCTION

In the northern Gulf of Mexico (GOM), bottlenose dolphins (*Tursiops truncatus*) range from inshore waters (bays, sounds, and estuaries), across the continental shelf, to upper continental slope waters (Mullin and Hansen 1999). The Marine Mammal Protection Act (MMPA), as amended in 1994, stipulates that marine mammals in U.S. waters be managed and protected as stock units, that each stock be maintained at or above the optimum sustainable population (OSP), and that each stock remains a functioning part of the ecosystem it inhabits. OSP is the population level between carrying capacity and the level resulting in maximum net productivity, and while it is not well defined, it is above 50% of the carrying capacity (Gerrodette and DeMaster 1990).

NOAA Fisheries divided bottlenose dolphins in the northern GOM into 38 stocks: one oceanic (waters >200 m deep), one continental shelf (20 - 200 m deep), three coastal (GOM shore - 20 m deep), and 33 inshore (Waring et al. 2007). The distinct stock status for each of the 33 inshore areas of contiguous, enclosed, or semi-enclosed bodies of waters is "community-based." That is, it is based on the finding, through photo-identification (photo-ID) studies, of relatively discrete dolphin "communities" in the few GOM areas that have been studied (Waring et al. 2007). This finding was then generalized to all enclosed inshore GOM waters where bottlenose dolphins exist. A "community" consists of resident dolphins that regularly share large portions of their ranges, and interact with each other to a much greater extent than with dolphins in adjacent waters. The term, as adapted from Wells et al. (1987), emphasizes geographic, and social relationships of dolphins. Bottlenose dolphin communities do not necessarily constitute closed demographic populations, as individuals from adjacent communities may interbreed. Nevertheless, the geographic nature of these areas and long-term stability of residency patterns suggest that many of these communities exist as functioning units of their ecosystems, and under the MMPA must be maintained as such. Also, the stable patterns of residency observed within communities suggest that long periods would be required to repopulate the home range of a community were it eradicated or severely depleted.

The distinct stock status for the three coastal regions (western, northern, eastern), continental shelf, and oceanic waters is based on the assumption that the dolphins occupying habitats with dissimilar climactic, physiographic, oceanographic, and prey characteristics might restrict their movements between habitats and develop unique genetic/cultural/behavioral profiles. However, biological data from genetic, tagging, or photo-ID studies have not been undertaken to test this assumption.

Understanding bottlenose dolphin stock structure throughout the GOM will require much additional information. The majority of the stock structure knowledge of inshore bottlenose dolphins comes from long-term research programs in Texas and peninsular Florida, and comparatively little research has been conducted in inshore areas of the Central GOM (*i.e.*, western Florida Panhandle, Alabama, Mississippi, and Louisiana) (Figure 1, Table 1). The development of biologically-based criteria to better define and manage stocks should integrate multiple approaches, including studies of ranging patterns, genetics, morphology, social patterns, distribution, life history, prey preferences, and contaminant concentrations. Here we propose research that incorporates these multiple approaches focusing on inshore and coastal stocks in the central northern GOM, and the shelf and oceanic stocks throughout the northern GOM, following a similar effort to define bottlenose dolphin stock structure on the U.S. Atlantic coast (Hohn 1997).

II. NOAA FISHERIES MANDATES AND GOALS

The initial focus of marine mammal research in response to the MMPA as implemented in 1972 was to monitor trends in abundance over time by conducting assessment surveys. Because of low statistical power (Gerrodette 1987) to detect trends of most estimates, and in response to the 1994 amendments to the MMPA, one of which governs the taking of marine mammals incidental to commercial fisheries, the focus was shifted from population trend analysis to estimating potential biological removal (PBR) and human-caused mortality on a stock basis (Barlow et al. 1995). PBR is the maximum number of marine mammals that can be removed from a stock by non-natural mortality (or permanent capture removals) while allowing the population to reach or maintain its OSP.

Therefore, it is imperative that stocks be accurately defined and human impacts be assessed for each stock. NOAA Fisheries estimates annual human-caused mortality and PBR. PBR is calculated following specific criteria using the estimated abundance of the stock, its maximum net productivity rate (theoretical or estimated), and a recovery factor (Barlow et al. 1995, Wade and Angliss 1997). NOAA Fisheries is required to prepare an annual Stock Assessment Report (SAR) for each stock to update abundance, stock structure, maximum net productivity, human-caused mortality, PBR, and status (*e.g.*, Waring et al. 2007).

Mitigating human-caused marine mammal mortality from commercial fisheries has been the primary focus of NOAA Fisheries marine mammal management. However, there are multiple and in some cases unique anthropogenic risk factors in the GOM (see Section IV) which could potentially lead directly to marine mammal mortality, reduced fitness (*i.e*., reduced maximum net productivity rate), and/or degraded habitat (*i.e*., reduced carrying capacity), and these have been largely underrepresented in management plans.

In 2001, NOAA Fisheries developed a Stock Assessment Improvement Plan (SAIP) for marine mammals (NMFS 2001). The status of the stock assessment for each stock was evaluated by eight information categories (Table 2) based on the quality of the information, and assigned a Level 0, 1, 2, 3, or 4 (0 = little or no information) for each category. Stocks then were assigned to tiers (Tier I, II, or III) based on this assessment. Bottlenose dolphin stocks in the GOM were determined to meet Level 1 criteria for stock identification (*i.e*., structure was inferred from analyses undertaken for other purposes), and to be Tier I stocks. The NOAA Fisheries PPBES (Planning, Programming, and Budgeting Execution System) requires that research be conducted to move stocks from Tier I to Tier II and eventually Tier III. Improving stock assessment to Tier II requires accurate and up-to-date abundance and fisheries bycatch estimates as well as a comprehensive analysis of stock structure. Because of the number and nature of the threats bottlenose dolphins in the GOM face (e.g., pollution, harmful algal blooms, habitat degradation), these stocks may be primary candidates for Tier III assessment in which an ecosystem approach and risk assessment analysis is necessary to accurately determine their status. NOAA's Strategic

Plan calls for a move toward an ecosystem-based approach to management where both biotic (including humans) and abiotic conditions are incorporated into the management of stocks (NMFS 2004).

III. OVERVIEW OF CURRENT STATE OF BOTTLENOSE DOLPHIN STOCK STRUCTURE KNOWLEDGE FOR THE GULF OF MEXICO

Inshore Stocks

Long-term (year-round, multi-year) residency by at least some individuals has been reported from nearly every inshore site where photo-ID or tagging studies have been conducted in the GOM. These include Matagorda-Espiritu Santo Bay, Aransas Pass, San Luis Pass, and Galveston Bay in Texas (Shane 1977, Shane 1980, Gruber 1981, Bräger 1993, Bräger et al. 1994, Fertl 1994, Weller 1998, Maze and Würsig 1999, Lynn and Würsig 2002, Henderson 2004, Irwin and Würsig 2004), and Choctawhatchee Bay, Tampa Bay, Sarasota Bay, Lemon Bay and Charlotte Harbor/Pine Island Sound in Florida (Irvine and Wells 1972, Irvine et al. 1981, Wells 1986a, Wells et al. 1987, Wells 1991, Scott et al. 1990, Shane 1990, Wells et al. 1996a, Wells et al. 1996b, Shane 2004). In the central northern GOM, four dolphins freeze-branded in 1982 in Mississippi Sound were sighted in the Sound 12-22 years later (Hubard et al. 2004; D. Yeater, pers. comm.). In addition to inshore areas, Fazioli et al. (2006) identified year-round resident bottlenose dolphins in coastal waters off central Florida.

Genetic studies also support the concept of relatively discrete inshore stocks. Analyses of mitochondrial DNA restriction fragment length polymorphism haplotype distributions indicate the existence of clinal variations along the GOM coastline (Duffield and Wells 2002). Mitochondrial DNA sequence analyses suggest finer-scale structural levels as well. For example, Matagorda Bay, Texas, dolphins appear to be relatively isolated from dolphins in the eastern GOM, and differences in haplotype frequencies distinguish adjacent communities in Tampa Bay, Sarasota Bay, and Charlotte Harbor/Pine Island Sound along the central west coast of Florida (Sellas et al. 2005). Differences in reproductive seasonality from site to site also suggest genetic-based distinctions between communities (Urian et al. 1996). A study also supports a genetic basis for the inshore-coastal partitioning of stocks in at least one location. Sellas et al. (2005) found significant differentiation between Sarasota Bay resident dolphins and those occurring primarily in the adjacent coastal GOM.

The long-term structure and stability of at least some of these communities is exemplified by the residents of Sarasota Bay, Florida, which have been observed since 1970 (Irvine and Wells 1972, Scott et al. 1990, Wells 1991). At least four generations of identifiable residents currently inhabit the region, including half of those first identified in 1970. Maximum immigration and emigration rates of about 2-3% have been estimated (Wells and Scott 1990).

Some genetic exchange may occur between resident dolphins that inhabit inshore waters (Sellas et al. 2005). Up to 30% of calves in Sarasota Bay apparently have been sired by non-residents (Duffield and Wells 2002). A variety of potential exchange mechanisms occur in the GOM. Small numbers of inshore dolphins traveling between regions have been reported, with patterns ranging from traveling through adjacent communities (Wells 1986b; Wells et al. 1996a, b) to movements over distances of several hundred km in Texas waters (Gruber 1981, Lynn and Würsig 2002, Würsig unpublished data). In many areas, year-round residents co-occur with non-resident dolphins, providing potential opportunities for genetic exchange. About 17% of group sightings involving resident Sarasota Bay dolphins include at least one non-resident as well (Wells et al. 1987). Similar mixing of inshore residents and non-residents is seen off San Luis Pass, Texas (Maze and Würsig 1999). Non-residents exhibit a variety of patterns, ranging from apparent nomadism recorded as transience in a given area, to apparent seasonal or non-seasonal migrations. Passes, especially the mouths of the larger estuaries, serve as mixing areas. For example, several communities mix at the mouth of Tampa Bay, Florida (Wells 1986a), and most of the dolphins identified in the mouths of Galveston Bay and Aransas Pass, Texas, were considered transients (Henningsen 1991, Bräger 1993, Weller 1998). Seasonal movements of dolphins into and out of some of the bays, sounds, and estuaries provide additional opportunities for genetic exchange with residents, and complicate the identification of stocks in coastal and inshore waters. In small bay systems such as Sarasota Bay, Florida, and San Luis Pass, Texas, residents move into GOM coastal waters in fall/winter, and return inshore in spring/summer (Irvine et al. 1981, Maze and Würsig 1999). In larger bay systems, seasonal changes in abundance suggest possible migrations, with increases in more northerly bay systems in summer, and in more southerly systems in winter. Fall/winter increases in abundance have been noted for Tampa Bay (Scott et al.[1]), and Charlotte Harbor/Pine Island Sound (Thompson[2]; Scott et al.[1]), and are thought to occur in Matagorda Bay (Gruber 1981, Würsig and Lynn 1996) and Aransas Pass (Shane 1977, Shane 1980, Weller 1998). Spring/summer increases in abundance occur in Mississippi Sound (Hubard et al. 2004) and are thought to occur in Galveston Bay (Henningsen 1991, Bräger 1993, Fertl 1994). Nevertheless, gene flow can be limited between embayments (perhaps due to the timing of movements relative to breeding season) and enough genetic differentiation occurs in some cases for the dolphins in each area to be treated (and managed) as a semi-isolated population (Sellas et al. 2005).

In the Central GOM, Mississippi Sound has been the location of the most bottlenose dolphin research. Studies include aerial and boat-based line-transect surveys, live capture and freeze-branding, and photo-ID. Aerial surveys have been conducted to estimate the abundance of dolphins in and near Mississippi Sound (Leatherwood et al. 1978, Thompson[3], Scott et al.[1], Blaylock and Hoggard 1994). Over 24 consecutive months during 1984 to 1986, a small boat was used to conduct abundance surveys which indicated that dolphin abundance in the Sound cycles annually (Lohoefener et al. 1990a). During both years, abundance in the Sound ranged from over 2000 dolphins in summer to less than 500 in winter. In response to an increase in

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[1] Scott, G.P., D.M. Burn, L.J. Hansen and R.E. Owen. 1989. Estimates of bottlenose dolphin abundance in the Gulf of Mexico from regional aerial surveys. *CRD88/89-07*. National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149.

[2] Thompson, N.B. 1981. Estimates of abundance of *Tursiops truncatus* in Charlotte Harbor, Florida. Fishery Data Analysis Division Report, National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, 75 Virginia Beach Drive, Miami, FL 33149.

[3] Thompson, N.B. 1982. Estimates of abundance of *Tursiops truncatus*, the bottlenose dolphin, in: St. Joseph-Apalachicola Bays, Florida, Mississippi Sound, Mississippi, and the Aransas-Copano-San Antonio Bay complex, Texas. Fishery Data Analysis Division Report, National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, 75 Virginia Beach Drive, Miami, FL 33149.

bottlenose dolphin strandings in the GOM during 1990 (Hansen[4]), the SEFSC instituted additional boat-based surveys to monitor trends in the abundance of bottlenose dolphins in the Sound. From 1991 to 1993 small boat surveys similar to those from 1984-1986 were conducted to coincide with the annual low (winter) and high (summer) abundance periods. While the winter and summer 1991 abundances were similar to those from the same periods of 1984-86, the summer population was smaller in 1992 and 1993. The summer 1993 estimate was 928 dolphins but this difference was not significant (NOAA Fisheries, unpublished).

NOAA Fisheries and the live-capture industry cooperated in a study in which individual Sound dolphins were captured and freeze-branded during 1982-1985 to study ranging and movements (Solangi and Dukes 1983, Lohoefener et al. 1990b). Since 1990, no dolphins have been removed from the GOM for captivity due to a self-imposed moratorium by the capture industry. Hubard et al. (2004), during a 16-month combined photo-ID/line-transect study of central Mississippi Sound (446 km^2), identified 515 individual dolphins, but resighting rates were low; the most frequently sighted dolphin was identified only seven times. However, based on the results from the freeze-branding and the Hubard et al. (2004) studies, there is evidence that individual dolphins tend to inhabit "inner-Sound" (near the Mississippi mainland) or "outer-Sound" (near the barrier islands) ranges, and this could potentially be a stock boundary (rather than Mississippi Sound proper). Preliminary photo-ID results support potential "inner-Sound" and "outer-Sound" ranging patterns for individual dolphins (Barry et al.[5]).

Currently, because of the age of the estimate (>8 years), there is no reliable abundance estimate from which to calculate PBR for most of the inshore stocks in the GOM and the three coastal stocks.

Coastal Stocks

GOM coastal waters are defined as waters from shore to 20 m deep and are divided into three bottlenose dolphin stocks (western, northern, eastern) based on habitat considerations. The 20-m isobath is a somewhat arbitrary dividing line, but bottlenose dolphins occur in higher densities close to shore than in deeper continental shelf waters (Waring et al. 2007) and there are more human activities such as fishing in these waters compared to deeper waters. The western stock is delimited by the U.S.-Mexico border and the Mississippi River delta, an area characterized by arid to temperate climate, sand beaches, and low fresh water input. The northern stock ranges from the Mississippi River Delta to 84.0^0 W, an area characterized by temperate climate, barrier islands, sand beaches, and coastal marshes, and with a relatively high level of fresh water. The eastern stock is from 84.0^0 W to Key West, Florida, and has a temperate to subtropical climate, is bordered by a mixture of coastal marshes, sand beaches, marsh and mangrove islands, and an intermediate level of freshwater input.

[4] Hansen, L.J. (ed). 1992. Report on investigation of 1990 Gulf of Mexico bottlenose dolphin strandings. NOAA-NMFS-SEFSC Contribution MIA-92/93-21.
[5] Barry, C.S., K. Maze-Foley, M.C. Mattson and K.D. Mullin. 2004. Site fidelity of bottlenose dolphins (*Tursiops truncatus*) in Mississippi Sound. Southeast and Mid-Atlantic Marine Mammal Symposium, 26-28 March 2004, Fort Pierce, Florida. Available from NMFS, 3209 Frederic Street, Pascagoula, MS 39567.

Other than abundance surveys (*e.g.*, Mullin et al. 1990, Blaylock and Hoggard 1994), research on coastal stocks is limited. Fazioli et al. (2006) conducted photo-ID surveys of coastal waters off Tampa Bay, Sarasota Bay, and Charlotte Harbor/Pine Island Sound over 14 months. They found coastal waters inhabited by both 'inshore' and 'Gulf' dolphins, but the two types used coastal waters differently. Dolphins from the inshore communities were observed occasionally in Gulf near-shore waters adjacent to their inshore range, whereas 'Gulf' dolphins were found primarily in open GOM waters with some displaying seasonal variations in their use of the study area. The 'Gulf' dolphins did not show a preference for waters near passes as was seen for 'inshore' dolphins, but moved throughout the study area and made greater use of waters offshore of waters used by 'inshore' dolphins. During winter months abundance of 'Gulf' groups decreased while abundance for 'inshore' groups increased. Seasonal movements of identified individuals and abundance indices suggest that part of the 'Gulf" dolphin community moves out of the study area during winter, but their destination is unknown. And while they found a mixture of ranging patterns (seasonal residency, transience), they did find some dolphins displayed many of the community structure characteristics of inshore dolphins. Off Galveston, Texas, Beier (2001) reported that bottlenose dolphins were present year-round in coastal waters but displayed low site fidelity. Resightings were low (85% of dolphins were sighted only once), but some dolphins had been sighted previously by other researchers over a 10-year period. Beier (2001) found that there was not a group of individuals that primarily utilized coastal waters off Galveston Island, but rather this area represented an overlap of outlying ranges of dolphins utilizing Galveston Bay (including the channels, jetties, and coastal waters near the bay entrance) at the northern end of the island, dolphins utilizing the Chocolate Bay/San Luis Pass area at the southern end of the island, and transient dolphins moving into and out of the area, possibly following shrimp boats.

Both "coastal/nearshore" and "offshore" ecotypes of bottlenose dolphins (Hersh and Duffield 1990) occur in the GOM (LeDuc and Curry 1998), and both could potentially occur in coastal waters. The offshore and nearshore ecotypes are genetically distinct using both mitochondrial and nuclear markers (Hoelzel et al. 1998). In the northwestern Atlantic, Torres et al. (2003) found a statistically significant break in the distribution of the ecotypes at 34 km from shore north of Cape Hatteras. The offshore ecotype was found exclusively seaward of 34 km and in waters deeper than 34 m. Within 7.5 km of shore, all animals were of the coastal ecotype. In the GOM off Louisiana, coastal waters, as defined here (i.e., waters ≤ 20 m deep), extend up to 70 km offshore and the coastal ecotype might inhabit water much more distant from shore than in the Atlantic.

Continental Shelf and Oceanic Stocks

The continental shelf stock, defined as dolphins occurring in waters 20 – 200 m deep, may overlap with coastal stocks and the oceanic stock in some areas, and may be genetically indistinguishable from those stocks. If the distribution of ecotypes found by Torres et al. (2003) is similar in the northern GOM, the oceanic stock, defined as dolphins occurring in waters >200 m deep, consists of the offshore ecotype. Biopsy samples have been obtained from bottlenose dolphins in the shelf and oceanic areas (Figure 2) but have not yet been analyzed. Analysis of these samples is a priority of the work proposed here. Abundance estimates of bottlenose dolphins for these two stocks have recently been updated (Fulling et al. 2003, Mullin and Fulling 2004).

IV. RISKS TO BOTTLENOSE DOLPHINS IN THE GULF OF MEXICO FROM HUMAN ACTIVITIES

Human activities that potentially pose risks to marine mammals including bottlenose dolphins are manifold (Reynolds et al. 2000). Broadly, these include industrial activities (*e.g*., oil and gas exploration, production, and refining; chemical production), commercial and recreational fishing, agricultural runoff, commercial and recreational vessel traffic, habitat loss, and underwater noise from a variety of sources (e.g., ships, military sonar, seismic exploration). Each of these, of course, is not unique to the GOM. While the effect of each on marine mammals is not well understood, what is known is addressed by a number of researchers (*e.g*., Simmonds and Hutchinson 1996). All of these human activities are extremely prevalent in the Central GOM, and probably more so than in any other part of the U.S. Some of the effects of human activities on marine mammals are acute (e.g., trauma from boat collisions, entanglement in fishing gear), but the effects of most are probably chronic and much less tractable (e.g., Schwacke et al. 2002). Therefore long-term population monitoring and research is probably the only way to assess how human activities affect marine mammals (e.g., Wells et al. 2004).

<u>Acute Effects of Human Activities Inferred from Stranding Data</u> - The Southeast Regional Stranding Network is a component of the Marine Mammal Health and Stranding Response Program (MMHSRP), a MMPA-mandated program (Title IV). The goals of the MMHSRP are to facilitate collection and dissemination of data, assess health trends in marine mammals, correlate health with other biological and environmental parameters, and coordinate effective responses to unusual mortality events (Becker et al. 1994). Volunteer participants acting under a letter of agreement with NOAA Fisheries collect data on stranded animals that include: species, event date and location, details of the event including evidence of human interactions, determinations of the cause of death, animal disposition, morphology, and biological samples.

A total of 1,377 bottlenose dolphins were found stranded in the U.S. GOM from 1999 to 2003 (Table 2 in Waring et al. 2007). Of these, 11% showed evidence of human interactions as the cause of death (e.g., gear entanglement, mutilation, gunshot wounds, and boat strikes). There are a number of difficulties associated with the interpretation of stranding data. It is difficult to assign a stranded dolphin to a specific stock because it is possible that the carcass drifted or that the animal's movement patterns were atypical prior to death. Therefore, the proportion of stranded dolphins belonging to a stock cannot be determined because of the difficulty of determining from where the stranded carcass originated. Stranding data probably underestimate the extent of human-related mortality and serious injury because not all of the dolphins which die or are seriously injured in human interactions wash ashore, nor will all of those that do wash ashore necessarily show signs of human-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of human-interaction, and the condition of the carcass if badly decomposed can inhibit the interpretation of cause of death.

<u>Broad Ecosystem Changes</u> - The chronic effects of human activities on the marine ecosystem and bottlenose dolphins are very difficult to assess. While all risk factors could be included under "ecosystem," a number of human activities are pervasive in the Central GOM. These include, to name a few, biomass removal by commercial and recreational fishing, sediment and

grassbed disturbance by trawl fisheries, bycatch from trawl fisheries, the creation of "reef" habitats due to oil and gas platforms along with the possible redistribution of ecosystem energy compared to pre-industrialization, and underwater noise created by shipping, dredging, the oil and gas industry, and the military.

Commercial fisheries biomass removal makes a good example because the removal can be quantified although the effects on bottlenose dolphins are unknown. During the period from 1999 to 2003, commercial fisheries landings in the northern GOM averaged almost 800,000 metric tons annually. (For the U.S. Atlantic, an average of 700,000 metric tons was landed annually.) Gulf menhaden (*Brevoortia patronus*) landings in the northern GOM during this period averaged just over 580,000 metric tons annually or 74% of the total landings. Most of the menhaden landings were concentrated in Louisiana (490,000 metric tons annually) followed by Mississippi (90,000 metric tons) (Smith et al. 2002). Menhaden inhabit inshore and coastal waters in the northern GOM and are most common off Louisiana, Mississippi, and Alabama. The GOM menhaden fishery is by weight the largest commercial fishery in the U.S. (Lassuy 1983). Menhaden are prey of numerous fish species and other marine predators including bottlenose dolphins (Barros and Odell 1990, Barros and Wells 1998).

Chemical Pollution - The coastal and inshore habitats occupied by many bottlenose dolphin stocks are adjacent to areas of high human population, and in some bays, such as Mobile Bay, Alabama, and Galveston Bay, Texas, are highly industrialized. The area surrounding Galveston Bay, for example, has a coastal population of over 4 million people. Bordering the Bay are half of the U.S.'s chemical production facilities and one-third of its oil refining capacity (Henningsen and Würsig 1991, Texas Commission on Environmental Quality 2006, Galveston Bay Foundation [www.galvbay.org]). The concentration of industry, shipping operations, and urban development have put Galveston Bay at risk for spills and dumping of oil and toxic materials. Contamination from runoff is also a water quality problem. Many of the enclosed bays in Texas are surrounded by agricultural lands which receive periodic pesticide applications. Pollution and contaminants have made many parts of Galveston Bay unsuitable for fishing and swimming, and have led to advisories to residents not to eat seafood caught along the upper Houston Ship Channel and adjacent areas (Texas Commission on Environmental Quality 2006).

Concentrations of chlorinated hydrocarbons and metals were examined in conjunction with an anomalous mortality event of bottlenose dolphins in Texas bays in 1990 and found to be relatively low in most; however, some had concentrations at levels of possible toxicological concern (Varanasi et al.[6]). No studies to date have determined the amount, if any, of indirect human-induced mortality resulting from pollution or habitat degradation. However, a study of PCB concentrations of dolphins in Sarasota and Matagorda Bays indicates concentrations high enough to impair reproductive success in females, particularly primiperous females (Schwacke et al. 2002).

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[6] Varanasi, U., K.L. Tilbury, D.W. Brown, M.M. Krahn, C.A. Wigren, R.C. Clark and S.L. Chan. 1992. Pages 56-86 *in* L. J. Hansen (ed), Report on Investigation of 1990 Gulf of Mexico Bottlenose Dolphin Strandings, Southeast Fisheries Science Center Contribution MIA-92/93-21. 219 p.

Unusual Mortality Events and Die-offs - Since 1990, there have been eight bottlenose dolphin die-offs in the northern GOM. From January through May 1990, a total of 367 bottlenose dolphins stranded in the northern GOM. Overall this represented a two-fold increase in the prior maximum recorded strandings for the same period, but in some locations (*i.e.*, Alabama) strandings were 10 times the average number. The cause of the 1990 mortality event could not be determined (Hansen[4]). In March and April 1992, 111 bottlenose dolphins stranded in Texas, which was about nine times the average number. Seven of 34 live-captured bottlenose dolphins (20%) in 1992 from Matagorda Bay, Texas, tested positive for previous exposure to cetacean morbillivirus, and it is possible that other estuarine resident stocks have been exposed to the morbillivirus (Duignan et al. 1996).

In 1992, NOAA Fisheries' Working Group on Unusual Marine Mortality Events was formalized under the MMPA (Sec. 404) and developed protocols to declare Unusual Mortality Events (UME) and respond to them. Since 1992, seven UMEs involving bottlenose dolphins have been investigated in the GOM. In 1993-1994 a UME of bottlenose dolphins caused by morbillivirus started in the Florida Panhandle and spread west with most of the mortalities occurring in Texas (Lipscomb 1993, Lipscomb et al. 1994). In 1996 a UME was declared for bottlenose dolphins in Mississippi and while the cause was not determined, a biotoxin from the dinoflagellate *Karenia brevis* (red tide) was suspected. Between August 1999 and May 2000, 152 bottlenose dolphins died coincident with *K. brevis* blooms and fish kills in the Florida Panhandle (additional strandings included 3 Atlantic spotted dolphins, *Stenella frontalis*, 1 Risso's dolphin, *Grampus griseus*, 2 Blainville's beaked whales, *Mesopolodon densirostris*, and 4 unidentified dolphins). In March and April 2004, in another Florida Panhandle UME possibly rated to *K. brevis* blooms, 107 bottlenose dolphins stranded dead (NOAA Fisheries 2004). Although there was no indication of a *K. brevis* bloom at the time, high levels of brevetoxin were found in the stomach contents of the stranded dolphins (Flewelling et al. 2005). From February through April 2004, 220 bottlenose dolphins were found dead on Texas beaches, of which 67 occurred in a single 10-day period. In 2005, a particularly destructive red tide (*K. brevis*) bloom occurred off of central west Florida. Manatee, sea turtle, bird and fish mortalities were reported in the area in early 2005 and a manatee UME had been declared. Dolphin mortalities began to rise above the historical averages by late July 2005, continued to increase through October 2005, and were then declared to be part of a multi-species UME. The multi-species UME extended into 2006, and ended in November 2006. A total of 190 dolphins were involved, primarily bottlenose dolphins (plus strandings of 1 Atlantic spotted dolphin, *S. frontalis*, and a few unidentified dolphins). The investigation into this event is still ongoing, however, the evidence is highly suggestive of a relationship between the red tide bloom and the dolphin deaths. Finally, a separate UME was declared in the Florida panhandle after elevated numbers of dolphin strandings occurred in association with a *K. brevis* bloom in September 2005. Dolphin strandings remained elevated through the spring of 2006 and brevetoxin was again detected in the tissues of some of the stranded dolphins. Between September 2005 and September 2006 when the event was officially declared over, a total of 94 bottlenose dolphin strandings occurred (plus strandings of 1 striped dolphin, *Stenella coeruleoalba*, and 4 unidentified dolphins).

Feeding and 'Swim-with' Dolphin Activities - Feeding or provisioning, and swimming with wild bottlenose dolphins have been documented in Florida, particularly near Panama City Beach in the Panhandle (Samuels and Bejder 2004). Feeding wild dolphins is defined under the MMPA as amended in 1991 as a form of 'take' because it can alter their natural behavior and increase their risk of injury or death. Nevertheless, Samuels and Bejder (2004) observed a high rate of uncontrolled provisioning near Panama City Beach in 1998. The effects of swim-with activities on dolphins and their legality under the MMPA are less clear and are currently under review. Near Panama City Beach, Samuels and Bejder (2004) concluded that dolphins were amenable to swimmers due to provisioning.

Wetland Loss - Louisiana is estimated to contain 41% of the coastal wetlands in the U.S. Due to a number of natural factors (*e.g.*, rising sea levels) and human activities (*e.g.*, levees, canal dredging), Louisiana is estimated to lose 40 to 60 square miles of coastal wetland annually (Gore 1992). These wetlands serve as important habitat for juvenile fishes, many species of which certainly are important prey for bottlenose dolphins.

Hypoxia (Dead Zone) - The Mississippi River, which drains about two-thirds of the continental U.S., flows into the north-central GOM and deposits its nutrient load which is linked to the formation of the second largest area of oxygen-depleted coastal waters in the world. This area is located in Louisiana coastal waters west of the Mississippi River delta, and in midsummer encompasses about 20,000 km^2. The absence of shrimp and demersal fish from hypoxic areas in the northern GOM is documented, but we do not know how this affects coastal bottlenose dolphins that inhabit the area (Rabalais et al. 2001). A reduction in available prey may force some/most dolphins to vacate this area during summer months when the hypoxia is most widespread.

Superfund - Gore (1992) reported 25 U.S. Environmental Protection Agency Super Fund Sites in U.S. GOM coastal counties. A Superfund Site is any land in the United States that has been contaminated by hazardous waste and identified by the EPA as a candidate for cleanup because it poses a risk to human health and/or the environment. There are currently 41 Superfund Sites in U.S. GOM coastal counties (www.epa.gov/superfund).

Oil & Gas - Over 70% of the oil and natural gas deposits extracted from U.S. waters come from the northern GOM (Würsig et al. 2000) where there are nearly 4,000 oil and gas related platforms with over 50 in waters deeper than 200 m (U.S. Minerals Management Service, unpublished data). Associated with these platforms are boat and helicopter traffic, seismic exploration, pipelines, and explosive platform removal, as well as the potential for leaks and spills of chemicals and oil, and marine debris. Development of numerous liquefied natural gas (LNG) terminals is planned for the northwestern GOM. Some of these terminals are water-based in nearshore coastal waters and others are land-based on the coastal mainland.

Shipping - Almost 45% of the total U.S. shipping tonnage occurs in the GOM (Würsig et al. 2000). In terms of maritime activity, the GOM is a very busy place. Both by number of vessels and by vessel capacity, about one-third (30.6% of vessel calls, 34.2% of vessel capacity) of all activity at U.S. ports occurs in the GOM. Of the top 20 U.S. ports, the GOM contains 5 of the top 20 in terms of number of vessel calls (Houston, New Orleans, Port Arthur, Texas City, and Tampa), and 7 of the top 20 in terms of vessel capacity (Houston, New Orleans, Port Arthur, LOOP Terminal, Texas City, Corpus Christi, and Lake Charles). On a global scale, Houston is the 9th busiest port in the world in terms of vessel calls, and the 8th busiest port in terms of vessel capacity. New Orleans is the 19th busiest port in the world in terms of vessel capacity (Office of Statistical and Economic Analysis 2006). With the shipping activity also comes the associated wastes (sewage, bilge washings, galley wastes, marine debris, and accidental discharges of hazardous material such as oil [Würsig et al. 2000]), noise pollution, dredging of waterways to maintain shipping lanes, and potential accidents/spills.

<u>Marine Debris</u> – Floating marine debris in the form of plastic, rope, and lumber is extremely abundant and pervasive throughout all northern GOM marine environments (Lecke-Mitchell and Mullin 1992, 1997). Ingestion of or entanglement in debris can result in injury or death (e.g., Gorzelany 1998).

<u>Boat Strikes</u> - Bottlenose dolphins have been struck by recreational and commercial vessels in the GOM, and as vessel traffic increases, there is concern that more dolphins may sustain injuries or be killed as a result (Wells and Scott 1997).

<u>Live Capture Removals</u> - GOM inshore areas were the focus of a live-capture fishery for bottlenose dolphins which supplied dolphins to the U.S. Navy and to oceanaria for research and public display for almost two decades (NOAA Fisheries, unpublished data; Reeves and Leatherwood 1984). From 1972-1989, 490 bottlenose dolphins, an average of 29 dolphins annually, were removed from a few locations in the GOM, including the Florida Keys. The live-capture fishery in Mississippi Sound was the largest with 202 bottlenose dolphins (an average of 12 dolphins annually) permanently removed (Scott 1990). The annual average number of removals never exceeded the current PBR of 13 dolphins, but it may be biologically significant that 73% of the dolphins removed during 1982-88 were females.

<u>Fisheries</u> - Bottlenose dolphins are known to become entangled in both recreational and commercial fishing gear (Gorzelany 1998, Wells and Scott 1994, Wells et al. 1998) in the GOM, but little is known about the effects of recreational fishing on bottlenose dolphins. Under the MMPA (Sec. 118, 16 USC 1387), NOAA Fisheries is required to monitor the effects of commercial fisheries on marine mammals, to publish a List of Fisheries annually, and to place each into one of three categories based on level of mortality or serious injury to marine mammals in that fishery: Category I – frequent, Category II – occasional, and Category III – remote. The following is a summary of the commercial fisheries in the GOM and how they are known to interact with bottlenose dolphins.

Gulf of Mexico Large Pelagics Longline

Large pelagic fish species including swordfish, yellowfin tuna, bigeye tuna, bluefin tuna, albacore tuna, dolphin fish, shortfin mako shark, and a variety of other shark species are target species. During 2000-2004, the average number of vessels reporting effort each year was 74, and for 2005 the number of vessels reporting effort was 60. The fleet operates both in continental shelf and deep continental slope waters from Florida to Texas. The large pelagics longline fishery is listed as a Category I fishery in the 2007 List of Fisheries (72 FR 59, 50 CFR Part 229) due to frequently observed interactions with marine mammals. The majority of interactions with marine mammals in this GOM fishery have been with Risso's dolphin (*Grampus griseus*) (Garrison 2003); however, there have been very few interactions with marine mammals observed in the last five years.

Gulf of Mexico Shrimp Trawl

The shrimp trawl fishery operates throughout the GOM coast of the U.S. virtually year-round. Hundreds of thousands of fishing trips are reported annually in the GOM with effort occurring in both estuarine, nearshore coastal, and offshore continental shelf waters (Epperly et al. 2002). Observer coverage is typically sparse and is not systematic. The shrimp trawl fishery has long been the focus of management actions associated with significant bycatch of both fish species and marine turtles. Occasional interactions with bottlenose dolphins have been observed in the Atlantic component of this fishery, and there is infrequent evidence of interactions from stranded animals. The shrimp fishery is listed as a Category III fishery in the 2007 List of Fisheries (72 FR 59, 50 CFR Part 229).

Gulf of Mexico Blue Crab Trap/Pot Fisheries

The blue crab trap/pot fishery is broadly distributed in estuarine and nearshore coastal waters throughout the GOM coast. The fishery is estimated to have approximately 4,000 participants deploying gear on a year-round basis (68 FR 41725). Pots are baited with fish or poultry and are typically set in rows in shallow water. Pot position is marked by either a floating or sinking buoy line attached to a surface buoy. In recent years, reports of strandings in the Atlantic with evidence of interactions between bottlenose dolphins and both recreational and commercial crabpot fisheries have been increasing in the Southeast Region (Burdett and McFee 2004). Interactions with crab pots appear to generally involve a dolphin becoming wrapped in the buoy line. The total number of these interactions and associated mortality rates has not been documented. The fishery has been defined as a Category III fishery in the 2007 List of Fisheries (72 FR 59, 50 CFR Part 229).

Gulf of Mexico Menhaden Fishery

This fishery operates in coastal waters along the GOM coast, with the majority of fishing effort concentrated off of Louisiana. Fishing effort occurs both in bays and sounds and in nearshore coastal waters. Between 1994 and 1998, fishery effort averaged approximately 23,000 sets annually (Smith et al. 2002). No observer data is available for the GOM menhaden fishery; however, interactions with coastal bottlenose dolphins have been reported historically in Louisiana and for the similar Atlantic menhaden fishery. The fishery has been defined as a Category II fishery in the 2007 List of Fisheries (72 FR 59, 50 CFR Part 229).

The fishery was observed to take nine bottlenose dolphins (three fatally) in the GOM between 1992 and 1995 (NOAA Fisheries, unpublished data). There were 1,366 sets observed out of 26,097 total sets, which if extrapolated for all years suggests that as many as 172 bottlenose dolphins could have been taken in this fishery with up to 57 animals killed.

Gulf of Mexico Gillnet Fisheries

Gillnets are not used in Texas, and large gillnets were excluded from Florida state waters after July 1995, but fixed and runaround gillnets are currently in use in Louisiana, Mississippi, and Alabama. These fisheries, for the most part, operate year-round. They are state-controlled and licensed, and vary widely in intensity and target species. No marine mammal mortalities associated with gillnet fisheries have been reported in these states, but stranding data suggest that gillnet and marine mammal interaction does occur, causing mortality and serious injury. There are no effort or observer data available for these fisheries. The GOM gillnet fisheries are listed as Category II fisheries in the 2007 List of Fisheries (72 FR 59, 50 CFR Part 229).

V. STOCK STRUCTURE RESEARCH PLAN FOR THE CENTRAL NORTHERN GULF OF MEXICO

An expert panel reviewed NOAA Fisheries' stock structure for bottlenose dolphins in the GOM during a workshop in March 2000 (Hubard and Swartz 2002). The panel sought to describe the scope of risks faced by bottlenose dolphins in the GOM, and outline an approach by which NOAA Fisheries could most efficiently investigate stock structure in the GOM and integrate data with previous and ongoing studies. The panel agreed that it was appropriate to use the precautionary approach and retain the 38 named stocks until further studies are conducted, and made a variety of recommendations for future research (Appendix I, Hubard and Swartz 2002). The panel emphasized that it is important for researchers in the GOM to collaborate and identify and use samples/data that already exist. They emphasized the use of genetic and photo-ID techniques as the "cornerstone" of past and future GOM stock structure research (Appendix I).

Since the 2000 workshop, bottlenose dolphin research programs have continued in peninsular Florida and Texas. Several research efforts also have been conducted in the Central GOM including:

> In 2001 in response to the recommendations of the Workshop Panel, NOAA Fisheries continued photo-ID studies in Mississippi Sound (Barry et al.[5]). The Panel emphasized the importance of knowledge of the ranging patterns of individual dolphins to provide context for other types of studies that we plan to conduct in the future. The objective of this work was to establish higher resighting rates of individual dolphins by sampling smaller areas (<100 km^2) of the Sound. Once individual resighting histories are established for a number of dolphins, biopsy samples for genetic studies from individuals that appear to be residents to specific areas can be compared to each other and compared to individuals with more uncertain ranging patterns. The photo-ID results since 2001 support the "inner-Sound" and "outer-Sound" ranging pattern hypothesis for some individual dolphins.
>
> Pabody[7] conducted preliminary research on bottlenose dolphins in Perdido and Wolf bays, located near the Alabama-Florida state line, as part of her undergraduate studies at Spring Hill College (Mobile, Alabama). She found evidence of year-round site fidelity for some dolphins inhabiting Perdido Bay. She also suggested that as many as 200 dolphins may use the Bay. The last NOAA Fisheries abundance estimate for this bay was zero and was based on data collected in 1994. Pabody is currently a master's student at the University of

[7] Pabody, C.M. 2003. Bottlenose dolphins in an Alabama-Florida estuary. 15th Biennial Conference on the Biology of Marine Mammals. 14-19 December 2003, Greensboro, North Carolina, USA.(Abstract available from NMFS, 3209 Frederic Street, Pascagoula, MS 39567.)

Alabama and for her thesis studied seasonal occurrence and habitat use of individual dolphins in Wolf Bay. NOAA Fisheries partially supported Pabody's field-work conducted in 2006 and 2007. Her thesis should be available in early 2008.

In 2003, the Institute for Marine Mammal Studies (Gulfport, Mississippi) in collaboration with a number of research institutions began a bottlenose dolphin research program that focuses on wild dolphins in western Mississippi Sound and dolphins in captivity at Marine Life Oceanarium in Gulfport. The goals of this congressionally-funded program are to study bottlenose dolphin biology and natural history in Mississippi, and include ecology, behavior, genetics, immunology, parasitology, physiology, diseases, taxonomy, public education, and conservation.

Miller (2003) completed a study of bottlenose dolphins in the Barataria Basin in Louisiana. In the study she characterized dolphin habitat, and estimated abundance using photo-ID and mark-recapture methods.

To bring northern GOM bottlenose dolphin stocks to Tier II under NOAA Fisheries' SAIP, we propose a multi-disciplinary research approach similar to programs for the Atlantic Coast (Hohn 1997) and the GOM coast of Florida (Wells 2003). That is, we envision using multiple methods that include genetics, photo-ID, isotopes, telemetry, and contaminant analyses to aid in stock identification. As there are active bottlenose dolphin stock structure research programs in the GOM in peninsular Florida and parts of Texas, we will focus on the Central GOM inshore and coastal stocks and the northern GOM continental shelf and oceanic stocks, and propose research to elucidate the stock structure.

In the long term, stock assessment research will be implemented throughout the Central GOM and incorporated with similar work from Texas and Florida. Currently there are 15 bottlenose dolphin stocks for inshore waters in the Central GOM (Fig. 1). Because funding and staff are currently limited, we plan to begin research by focusing on one or two Central GOM areas per year and then, in the future, expand and direct research as funding allows and as is mediated by results. At a minimum, field work will focus on the following for both winter and summer seasons: (1) conducting capture-recapture studies using photo-ID to estimate dolphin abundance for each stock area, and (2) collecting biopsy samples to study inter- and intra-stock area genetic structure of stock areas as currently proposed by NOAA Fisheries.

The first phase of this research plan was implemented in 2005 and 2006 in Mississippi Sound. Mississippi Sound is shallow (1-7 m deep), 106 km long, 8 to 32 km wide (Eleuterius 1978), and covers an area of about 4,792 km^2. We chose Mississippi Sound for a number of reasons. This site was chosen because the NOAA Fisheries Pascagoula Laboratory is located on Mississippi Sound and the work could be done at lower cost (little travel costs). There is a large bottlenose dolphin population, knowledge of seasonal abundance patterns, evidence of long-term site-fidelity by some individuals, and a significant photo-ID catalog (900 individual dolphins) based on work conducted from the early 1980s to the present (Hubard et al. 2004). Mississippi Sound also represents a cross section of the human activities that could potentially impact bottlenose dolphins in the GOM, including shipping, commercial and recreational fishing, oil and gas development, dredging, and recreational boating. It also had the largest number of dolphin capture-removals (202) of any site in the GOM, and dolphins have been impacted by harmful algal blooms.

As stated, bottlenose dolphin abundance in the Sound changes seasonally (Hubard et al. 2004). The abundance peaks in the summer/early fall and is lowest in late winter/early spring. We anticipate that similar abundance patterns will occur in each Central GOM stock area. Therefore, both summer and winter photo-ID/biopsy field work will be necessary for each stock area.

In late summer 2005, 102 biopsy samples were collected from two non-adjacent sites in Mississippi Sound: near the mainland off Pascagoula and near East Ship Island (Figure 3). During summer 2006, thirty-eight biopsies were collected in GOM waters between the barrier islands and the 20-m isobath. In each area photo-ID sampling was conducted with an emphasis placed on obtaining a dorsal fin photo of biopsy-sampled dolphins. While analyses are pending, our assumption is that if genetic differences exist, they should be revealed by sampling three spatially non-contiguous areas with different habitats. These samples and subsequent Central GOM samples will analyzed at the SEFSC Marine Mammal Molecular Genetics Laboratory in Lafayette, Louisiana.

A photo-ID and biopsy survey is planned for Choctawhatchee Bay, Florida, for summer 2007. The objectives are to: (1) conduct a photo-ID survey for four weeks to collect data for a capture-recapture abundance estimate, and (2) conduct biopsy sampling subsequent to the photo-ID survey with a goal of collecting 30-50 samples. Choctawhatchee Bay was chosen as the first site in which to implement capture-recapture studies because its geography makes it amenable to meeting the assumptions of capture-recapture estimation methods. As logistic and analytical expertise with capture-recapture is developed, similar methods will be implemented at all other Central GOM inshore stock areas.

For each inshore stock area, biopsy samples will consist of both a skin sample for genetic studies and a blubber sample for contaminant studies. We will coordinate each biopsy sampling effort with the NOAA Fisheries, Marine Mammal Health and Stranding Response Program and collaborators (*e.g.*, National Ocean Service and National Institute of Standards and Technology), and provide samples for their marine mammal health studies. Contaminant profiles of bottlenose dolphins from stock areas can be another factor useful in understanding stock structure.

In addition to focusing on the inshore areas, Oceanic and Continental Shelf stocks will be investigated. During large-vessel surveys of the GOM, the SEFSC has collected 179 bottlenose dolphin biopsy samples since 1994 (Figure 2). Sample locations are distributed from coastal waters to the limit of bottlenose dolphin distribution in oceanic waters. The analyses of these samples, which are in the initial phase, could begin to answer a range of questions on the stock structure of pelagic bottlenose dolphins in the GOM, including the depth/distance from shore ranges of the offshore and coastal morphotypes, and defining the extent of overlap in the ranges of the two morphotypes. Another biopsy sampling survey of the northern GOM shelf waters is planned for summer 2007 to collect additional samples to achieve a more uniform distribution of samples east to west and across the depth gradient.

Future Research & Collaboration - The work from each stock will be assessed and adaptive sampling will be employed to focus research. That is, we will annually review results from previous years to determine the type and spatial-temporal distribution of necessary additional data collection, and the next sampling location. For example, if needed, collect additional biopsy samples in coastal, shelf and oceanic regions to fill in spatial-temporal gaps. Through time, the area from the panhandle of Florida to Texas will be covered.

We will also investigate the potential for collaborating with other GOM researchers and standardizing data collection by holding a meeting of all GOM bottlenose dolphin researchers in 2008 or 2009.

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Table 1. Central northern Gulf of Mexico inshore bottlenose dolphin stocks.

1.	Sabine Lake
2.	Calcasieu Lake
3.	Vermillion Bay West Cote Blanche Bay Atchafalaya Bay
4.	Terrebonne Bay Timbalier Bay
5.	Barataria Bay
6.	Mississippi River Delta
7.	Mississippi Sound Bay Boudreau
8.	Mobile Bay Bonsecour Bay
9.	Perdido Bay
10.	Pensacola Bay East Bay
11.	Choctawhatchee Bay
12.	St. Andrew Bay
13.	St. Joseph Bay
14.	St. Vincent Sound Apalachicola Bay St. Georges Sound
15.	Apalachee Bay
16.	*Chandeleur Sound *Breton Sound

*Chandeleur and Breton sounds are not currently identified as inshore stocks but are part of the Northern Gulf of Mexico Coastal Stock. Nevertheless, they are inshore waters.

Table 2. Explanation of Tiers under the NOAA Fisheries Protected Species Stock Improvement Plan.

Tier I – Improve stock assessments using existing data collection resources

Status quo: No new assessment efforts; simply maintain existing level of stock assessments and develop improved survey and analytic methods

Tier II – Elevate stock assessments to new national standards of excellence

Meet the mandates of the Endangered Species Act and Marine Mammal Protection Act by achieving Level 2 under Categories for abundance, assessment, fishery mortality, and stock identification for all stocks

Upgrade "assessments" of "core" species or identified stocks to Level 3 under Categories for abundance, assessment, mortality, and stock identification. Achieve for other Categories Levels 1-4 as appropriate

Conduct "process-like" research to meet needs of constituents and specifically, achieve Level 2 or greater under Categories of Behavioral and Physiological Responses to Noise for Core Species

Tier III – Next generation assessments

Collection of data in all Categories for Ecosystem Indicator Species to provide better understanding of how marine mammals function within their respective systems

Ecosystem based approach to assessments

Categories

- Population Characteristics
  - Population structure and stock identification
  - Abundance
- Threats
  - Fishery mortality
  - Other human-caused mortality
  - Human-related nonlethal effects or stressors
  - Disease
- Assessment of impact of threats
  - Frequency
  - Quality
- Habitat
  - Use/structure
  - Demography
  - Food habits/ ecological relationships
  - Threats to habitat
- Behavior and Physiology
  - Behavioral response to sound
  - Other behavior
  - Physiological response to sound

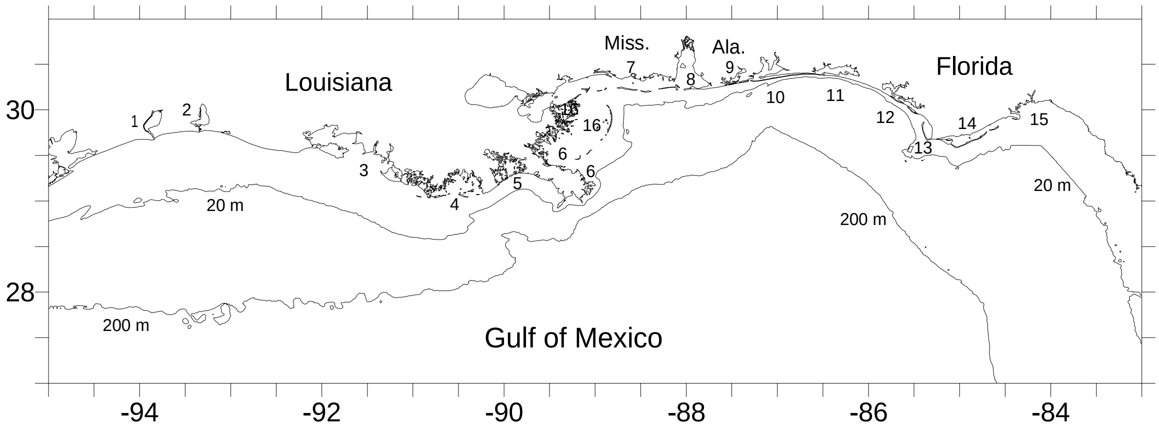

Figure 1. Locations of inshore bottlenose dolphin stocks in the Central Gulf of Mexico (see Table 1 for names corresponding to numbers).

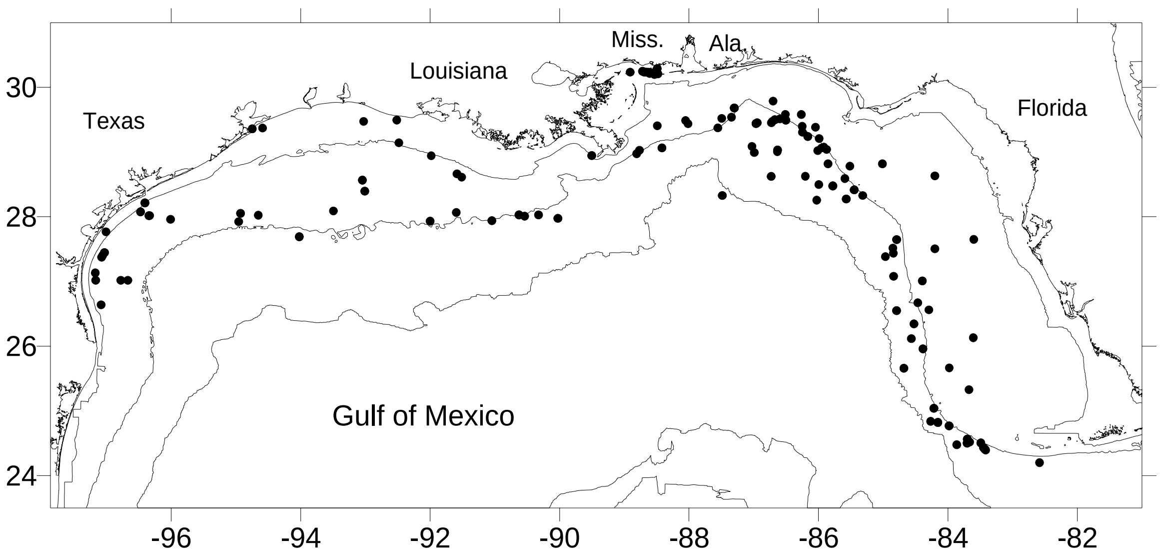

Figure 2. Locations of bottlenose dolphin biopsy samples (n = 179) collected by NOAA Fisheries. The 20, 1000 and 2000-m isobaths are shown.

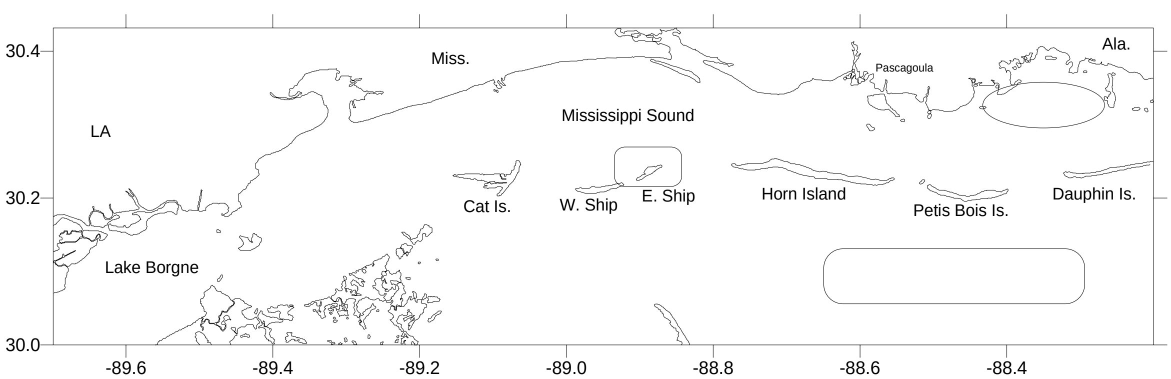

Figure 3. Locations of biopsy sampling sites in the Mississippi Sound region.

APPENDIX I

Recommendations of the expert review panel convened in March 2000 to review NOAA Fisheries' stock structure for Gulf of Mexico bottlenose dolphins (Hubard and Swartz 2002):

> Considering the available data on Gulf of Mexico bottlenose dolphins and taking into account geographical and methodological gaps in that data, the potential risks to bottlenose dolphins, and the overall theory of stock structure, the panel made a series of suggestions that would improve our understanding of bottlenose dolphin stock structure and status in the Gulf of Mexico. It is hoped that these suggestions should serve as a framework to guide future bottlenose dolphin research in the Gulf of Mexico, outlining higher priority research and aiding in the allocation of any future resources.
>
> 1. In the absence of conclusive evidence suggesting otherwise and with data showing some degree of site fidelity throughout the Gulf, it was suggested that the division of bottlenose dolphin stocks in the Gulf of Mexico remain at the current risk-adverse strategy of 38 different stocks.
>
> 2. To further understand the differences between inshore and offshore bottlenose dolphins, it was suggested that large-scale ship surveys be conducted along the continental shelf and slope. Line transect theory can be employed to estimate abundance of bottlenose dolphins and biopsies can be obtained to genetically distinguish between the two ecotypes and identify the distribution of each. These efforts may also help examine the unclear relationship between bottlenose dolphins and Atlantic spotted dolphins in regions where their distributions overlap and interbreeding may occur.
>
> 3. Recognizing that there are already samples in-hand that have not yet been analyzed, it was suggested that efforts be made to process and analyze available bottlenose dolphin samples from the Gulf of Mexico. These may include teeth and other tissues collected from live captures and strandings.
>
> 4. It was suggested that bottlenose dolphin researchers in the Gulf of Mexico begin or improve collaboration amongst themselves. The major joining force for Atlantic researchers is the Mid-Atlantic Bottlenose Dolphin Photo-Identification Catalog. Creating a centralized or at least regional photo-ID catalog(s) of bottlenose dolphins in the Gulf of Mexico would require and encourage cooperation among researchers and could lead to important discoveries regarding home ranges, movement patterns, and genetic dispersal. It is also suggested that, similar to the manatee library, a Gulf of Mexico bottlenose dolphin library be established or at least a CDROM be created with relevant bottlenose dolphin references.
>
> 5. The panel suggested that the stranding networks be included as part of the collaborative research effort and better utilized as they can provide a wealth of information on life history, feeding habits, and morphometrics as well as fishery interactions. However, the primary problem with strandings is the inability to determine with any certainty where the animal lived when it was healthy.

6. To aid in the assignment of a bottlenose dolphin carcass to one particular stock or region of the Gulf of Mexico, the panel discussed the use of chemical markers. It was suggested that a literature search be conducted to identify chemical pollutants occurring in different areas of the Gulf of Mexico. Furthermore, it was suggested that specific chemicals or ratios of chemicals present in bottlenose dolphin tissue be identified to serve as assignment tests. This research would probably involve the sampling of individuals (e.g., from photo-ID catalogs) with a known home range throughout the Gulf. Contaminant studies can also help assess the health of animals in a population.

7. To examine Gulf of Mexico bottlenose dolphin stock structure it was suggested that a framework be developed using multiple data sets similar to the geographically constrained hierarchical clustering method used to elucidate stocks of Alaskan harbor seals. Genetic sampling would be the primary tool in the hierarchical cluster approach. The first step could be a coordinated sweep across the Gulf collecting 40-50 genetic samples of known individuals approximately every 100 km. Other possible sources of data to contribute to the stock structure framework include: photo-ID, telemetry, toxicants, fatty acid signatures, and stable isotope ratios from teeth.

8. The panel discussed the importance of photo-ID studies. Photo-ID serves two main roles in the context of the multiple data set framework: 1) photo-ID is a means of ground-truthing models and dispersal rates generated from genetic sampling and 2) photo-ID is the primary tool for selecting individual animals to be sampled (e.g., via biopsy or radio/satellite tagging). Acknowledging the usefulness of photo-ID data and recognizing that photo-ID data become more meaningful over time, the panel suggested that photo-ID research continue at currently established sites. Since there are large geographical gaps in photo-ID studies along the Gulf coast, criteria for selecting new sites were suggested. It was suggested that new photo-ID research be conducted in locations: 1) where some data already exist from past studies, 2) with high (e.g., Galveston Bay) or unknown (e.g., Louisiana) levels of risk, 3) that are logistically easy to sample, 4) where known mortality events have occurred, and 5) where there is a reason to suspect a natural break in the population, such as where a sudden change in habitat occurs.